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INDEPENDENT SUSPENSION UNDERCARRIAGE MODULE FOR A LOW FLOOR VEHICLE

BACKGROUND OF THE INVENTION

[1] This invention relates to an independent suspension system, and more particularly to a suspension module which is attachable to a low floor mass transit vehicle.

[2] Mass transit vehicles, such as trolley cars, buses, and the like typically have seats aligned at the lateral sides of the vehicle, with a central aisle and floor extending along the vehicle. In order to facilitate entering and exiting from the vehicle, it is desirable to have the vehicle floor and aisle positioned relatively low to the ground. This provides increased passenger space within the body of the vehicle, and may allow the overall height of the mass transit vehicle to be reduced.

[3] Mass transit vehicles typically have several axles which support, drive and steer the vehicle. Many such vehicles provide a rigid axle having a gearbox at a longitudinal end to form an inverted portal axle configuration. Disadvantageously, this arrangement necessarily eliminates the ride benefits of independent suspension systems.

[4] In other known embodiments, independent suspension systems have been available which provide the low floor vehicle with the ride benefits inherent in independent suspension systems. Unfortunately, the individual assembly and attachment of each component of a rather more complex independent suspension system is a time consuming and labor intensive process. Moreover, it is difficult to integrate the systems as the multiple independent attachment points prevent the systems from being installed simultaneously. These difficulties are further complicated by the arrangement of a low floor vehicle.

[5] Accordingly, it is desirable to provide an independent suspension system which is attachable to a low floor mass transit vehicle in an uncomplicated manner.

SUMMARY OF THE INVENTION

[6] The present invention provides an independent suspension undercarriage module that is previously assembled and collectively mounted to a low floor vehicle thereby reducing the number of assembly steps and contributing to an improvement in productivity, quality and serviceability.

[7] The module includes a first subframe segment and a second subframe segment. The first subframe segment is located below a first profile segment of the vehicle floor which defines an aisle of a low floor vehicle while the second subframe segment is located below a second profile segment which defines the portion of the vehicle floor beneath the passenger seats.

[8] The subframe is preferably manufactured of a composite material to provide a truss-like structural unibody which is mounted to the underside of the vehicle through a plurality of resilient dampers. Passengers are thereby provided with a secondary vibration isolation structure separate from the suspension systems which filters out high frequency content generated by the suspension systems.

[9] The present invention therefore provides an independent undercarriage module which is attachable to a low floor mass transit vehicle in an uncomplicated manner and which provides additional passenger comfort.

BRIEF DESCRIPTION OF THE DRAWINGS

[10] The various features and advantages of this invention will become apparent to those skilled in the art from the following detailed description of the currently preferred embodiment. The drawings that accompany the detailed description can be briefly described as follows:

[11] Figure 1 is a cross sectional view of a vehicle incorporating the subject invention; and

[12] Figure 2 is a perspective view of an independent undercarriage module of the subject invention;

[13] Figure 3 is a schematic representative view of the structural rigidity of the subframe of the independent undercarriage module of Figure 2; and

[14] Figure 4 is an expanded view of one module attachment arrangement according to the subject invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[15] Figure 1 schematically illustrates an exploded cross-sectional view of a vehicle 10 which includes a passenger compartment 12 defined by a roof 14, two sidewalls 16, and a vehicle floor 18. The cross-sectional view is taken transverse to the vehicle length. That is, substantially across the vehicle width. The vehicle 10 includes a multiple of passenger seats 20 mounted adjacent to each of the sidewalls 16 with a center aisle 22 extending along the length of the vehicle 10 and between the seats 20. In order to facilitate entering and exiting the vehicle 10, it is desirable to have the vehicle floor 18 and aisle 22 positioned relatively low to the ground. This provides increased passenger space 12 within the body of the vehicle 10.

[16] The floor 18 defined beneath the passenger seats 20 and the aisle 22 defines at least two profile segments. A first profile segment 24 extends along a vehicle longitudinal axis 25 for a first length and a second profile segment 26 extends along the longitudinal axis 25 for a second length. The first profile segment 24 defines the floor of the aisle 22. The second profile segment 26 defines the floor 18 beneath the passenger seats 20. The profile segments 24, 26 further define an underside 28 of the vehicle 10.

[17] A set of vehicle wheels 30,32 are each mounted to an independent suspension system (illustrated somewhat schematically at 38, 40) adjacent the vehicle underside 28. It should be understood that vehicle 10 is typically provided with additional axles, driven and/or non-drive axles, and several sets of wheels including multiple pairs of wheels per axle.

[18] A first and second hub assembly 34,36 supports their respective wheels 30,32. The hub assemblies 34,36 each define a rotational axis 37 about which the vehicle wheels 30,32 are rotated. The hub assemblies 34,36 are each supported by the independent suspension system 38,40 which allow the independent articulation of each hub assembly 34,36. It should be realized that although a particular upper and lower suspension link arm configuration is illustrated in the disclosed embodiment, other independent suspension systems will benefit from the instant invention. The instant invention is particularly applicable to non-driven suspension systems such as a steerable front suspension system.

[19] The independent suspension systems 38,40 are preferably mounted to the underside 28 of the vehicle 10 as an independent undercarriage module 42. As will be further described below the module 42 is an integral unit previously assembled and collectively mounted to the vehicle 10.

[20] The module 42 includes a subframe 44 which is preferably substantially U-shaped but having a distal portion of the legs of the U bent outwardly. That is, the subframe includes a first subframe segment 46 and a second subframe segment 48 to substantially match the underside 28. The first subframe segment 46 is located below the first profile 26 segment of the floor 18 which defines the aisle 22. The second subframe segment 48 is located below the second profile segment 28 which defines the portion of the floor 18 beneath the passenger seats 20. The subframe 44 therefore supports the independent suspension systems 38,40 which are attached through the module 42 to the underside 28 of the vehicle 10.

[21] The independent suspension systems 38, 40 are mounted below the second subframe segment 48 and are preferably pivotally attached to a mount 51 mounted to an intermediate subframe segment 50 between the first subframe segment 46 and the second subframe segment 48.

[22] Referring to Figure 2, the subframe 44 is preferably manufactured of a composite material. Articles fabricated from fiber reinforced resin matrix composite materials are

known, and have found increasing use in load bearing structural applications due to their high strength, light weight, and ability to be fashioned into complex shapes.

[23] One technique for manufacturing composite components includes prepreg lay-up of composite materials. A composite component is formed from a substrate material having a plurality of parallel fibers that are saturated in a resinous material. The saturated fibers form a pre-impregnated (prepreg) material. The resulting impregnated substrate is considered a B-staged ply, ready for assembly ("lay up") into a laminate to be cured into a structural composite component.

[24] By orientating the fibers of each layer in particular directions, a truss-like (Figure 3) structural unibody is formed. Preferably, the layers are oriented to provide maximum stiffness in the torsional load. The subframe 44 is therefore relatively light, yet provides structural rigidity particularly tailored to the suspension systems 38,40 of the vehicle (Figure 1). It should be understood that the subframe illustrated in Figure 3, is representative of the torsional characteristics of the subframe 44 (Figure 2) which will preferably be formed as a single substantially continuous composite panel.

[25] The module 42 is mounted to the underside 28 of the vehicle 10 through a plurality of resilient dampers 52 (also illustrated in Figure 1). Fasteners 54 such as bolts or the like attach the module 42 to the underside 28 (Figure 4). The fasteners 54 are preferably located through the dampers 52, however, other fastener locations may also be provided. The dampers 52 are preferably formed of an elastomeric material such as rubber or the like which isolate the module 42 from the vehicle underside 28. It should be understood that other resilient mounts such as mechanical, pneumatic, hydraulic, or the like will also benefit from the present invention. Preferably, the dampers 52 filter out high frequency content generated by the suspension systems 38, 40. Passengers are thus provided with a secondary vibration isolation structure separate from the suspension systems 38, 40.

[26] The foregoing description is exemplary rather than defined by the limitations within. Many modifications and variations of the present invention are possible in light of the above

teachings. The preferred embodiments of this invention have been disclosed, however, one of ordinary skill in the art would recognize that certain modifications would come within the scope of this invention. It is, therefore, to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described. For that reason the following claims should be studied to determine the true scope and content of this invention.